CLASSIFICATION CONFIDENTIAL
SECURITY INFORMATION
CENTRAL INTELLIGENCE AGENCY

INFORMATION FROM
FOREIGN DOCUMENTS OR RADIO BROADCASTS

REPORT [redacted] 50X1-HUM

CD NO. [redacted]

COUNTRY USSR

SUBJECT Scientific - Chemistry, physics, geochemistry, petroleum prospecting

DATE OF INFORMATION 1950

HOW PUBLISHED Irregular periodical

DATE DIST. 29 May 1952

WHERE PUBLISHED Moscow/Leningrad

NO. OF PAGES 5

DATE PUBLISHED Apr 1950

LANGUAGE Russian

SUPPLEMENT TO REPORT [redacted] 50X1-HUM

THIS IS UNEVALUATED INFORMATION

SOURCE Trudy Instituta Nefti, Vol I, No 2, 1950, pp 3-25, [redacted] 50X1-HUM

NEW USSR METHODS OF PROSPECTING FOR PETROLEUM

S. F. Fedorov
Corr Mem Acad Sci USSR

Geochemical methods of prospecting, as distinguished from most geophysical methods, actually establish the presence of petroleum rather than merely aid in clarifying the nature of the geological structure. Geochemical methods include: (1) V. A. Sokolov's method of gas sampling, (2) method of taking gas samples that is based on investigation of the gases dissolved in water, (3) redox potential method, (4) hydrochemical method.

V. A. Sokolov's method is generally known. The redox potential method is being developed at the Petroleum Institute's Laboratory of Geochemical Bituminology under the direction of V. E. Levenson. It is based on the following principle. Petroleum exhibits a higher level of oxidation-reduction intensity than the surrounding rocks, i.e., its rH is lower than that of the rock strata. When one of the units composing a complex of redox systems has a capacity which greatly exceeds that of the others, the redox potential of the total complex will, for all practical purposes, be equal to that of the dominant system. It follows from this that wherever a sizable petroleum occurrence is present, the capacity of its redox factor will be sufficiently large in comparison with that of the surrounding rocks to exert a predominant influence. Levenson's investigations showed that in approaching a large petroleum occurrence, there is observed a regular decrease of the numerical values of rH which is not affected by considerable differences in the rock composition. No other factor except the presence of petroleum can produce this state of affairs.

The correctness of the theory on which this method of prospecting is based was first tested by carrying out measurements in the vicinity of known petroleum fields that are under exploitation. Practical application of the method proved

CLASSIFICATION CONFIDENTIAL

STATE	X	NAVY	X	NSRB		DISTRIBUTION									
ARMY	X	AIR	X	FBI							mapc	X			

to be successful: the rich Yamsamal'sk occurrence and the "Promezhutochnaya" and Troyekurovo-Gubinsk structures in the Syzran' region, which contain industrially exploitable petroleum occurrences, were located with its aid.

Further work on the rH method of prospecting will include investigation of the possibilities of its application in determining the depth of petroleum fields, as well as a study of the changes which rH standards undergo depending on the regions of the USSR in which prospecting is carried out. While gas sampling by methods (1) and (2) permits determination of the general outlines of a petroleum field, the redox potential method permits a more precise plotting of the field and, in all probability, also determination of its depth.

Of great help in petroleum prospecting is V. A. Sulin's hydrochemical method. There are four types of subterranean water. In the order of their occurrence in depth (starting from the surface), waters belong to the sodium sulfate, sodium carbonate, magnesium chloride, or calcium chloride types. Water of the sodium sulfate type is surface water. Its presence indicates that the geological structure is open. When this water occurs at a considerable depth and is of a low concentration, the chances are poor that petroleum is present. Magnesium chloride and calcium chloride waters (particularly the latter) are the end products of water transformation in depth. Water of the calcium chloride type indicates that the geological structure is closed to a high degree and consequently that conditions are favorable for the preservation of petroleum, if the latter is present. However, when the cross section is of a pronounced sulfate type, waters which are intermediate between the sodium sulfate and magnesium chloride types and also exhibit a high concentration may indicate that the structure is closed to a considerable extent (e.g., Buguruslan).

Direct evidence of the possibility of the presence of petroleum is given by water which contains naphthenic acids and dissolved liquid and gaseous hydrocarbons. Indirect evidence of petroleum is furnished by water having a high content of iodine and hydrogen sulfide and showing a low content (or total absence) of sulfates. The bromine content apparently has no bearing on the presence or absence of petroleum.

Lately, increased importance is being attached by petroleum specialists to the question of whether an occurrence is primary or secondary. This question is not of theoretical interest only, but has a definite practical significance. The solution of the problem involved can be achieved in the following ways: (a) by applying general geological methods, i e., by determining where and how the petroleum and solid bitumens are depostied, (b) by subjecting to a thorough investigation petroleum crudes from various levels ["horizons"], occurrences, regions, and areas, and comparing these crudes with each other, and (c) by studying the trace elements associated with various petroleum crudes and bitumens.

In the oil-bearing layer of Second Baku, the presence of petroleum in the cracks of rock occurrences and its absence in the surrounding rock serve as clear proof of the secondary nature of the petroleum found in this layer. Application of bituminological investigations may also shed light on the question of whether a deposit is primary or secondary. Thus, a comparative investigation of petroleum and bitumen occlusions found in the productive thickness of the Apsheron Peninsula and the Maykop strata of the Caspian region, which was carried out by Levenson, disclosed significant differences in the bituminous formations typical for these two stratigraphic units. Clays absorb the asphaltene-resin fraction of petroleum crudes more readily than do sands. However, in both clays and sands the concentration of asphaltene-resin components must be higher than in petroleum crudes. These relationships are observed in the Maykop strata, but not in the productive thickness. The only reasonable explanation for this difference is that the petroleum in the layers of the productive thickness must

be of a secondary nature. In secondary dep[redacted], petroleum, after being exposed to the conditions existing in the new bed, undergoes considerable changes, which continue during the period when adsorption of bituminous occlusions by the surrounding rocks has been completed. At the same time, the chemical activity of bituminous occlusions adsorbed by the rocks is lowered in comparison with the bituminous fraction which is still contained in the petroleum. This applies particularly to clays. For that reason, subsequent changes will proceed much less rapidly in the rock occlusions than in the petroleum itself.

If the medium into which the petroleum migrates has a less pronounced reducing character than the medium in which it was originally formed, the subsequent changes will be produced by oxidation. Then the petroleum will be oxidized more intensively than the adsorption compounds with rock material, so that finally the petroleum may become richer in the asphaltene-resin fraction than the rock adsorption compounds. Similar factors may disturb the correct relationship between bituminous formations in clays and sands. We then find the conditions observed in the Azerbaydzhan productive thickness. Cases in which the petroleum migrates into a medium which is more highly reductive than the mother strata are quite exceptional.

In primary sites, both petroleum and bituminous occlusions have not exposed to any new conditions since formation and, for that reason, do not undergo any particular changes. Relationships of the normal type will prevail, i.e., they will correspond to those which are found in the Maykop strata. Thus investigation of the asphaltene-resin fractions in petroleum crudes of the productive thickness and of the Maykop strata has demonstrated the secondary nature of petroleum occurring in the Azerbaydzhan productive thickness. The criterion applied here holds not only for terrigenous, but also for carbonate deposits.

A second method developed by Levenson's laboratory is applicable in cases where regional relationships can be established by determining the character of bituminous formations.

A third method of investigation is based on comparing petroleum crudes from various stratigraphic levels or on comparing bituminous occlusions along various paths of petroleum migration. Under certain conditions, comparison of data obtained by specific gravity measurements and by determination of the content of asphaltene-resin components or some other easily adsorbed component may aid in establishing the type of the deposit and the genetic relationships pertaining to it. In geological structures in which migration proceeds along disrupted zones, the intensity of adsorption processes along the course of petroleum migration is comparatively low. In such cases, correspondence of petroleum composition to the adsorptive properties of collectors serves as an index of the genetic connection between petroleum crudes of different levels.

As shown in L. A. Gulyayeva's investigations, petroleum crudes and natural bitumens genetically connected with them which occur in deposits of different geological age have an ash composition that is characteristic for a definite age of the petroleum. In other words, petroleum of a definite age yields ash having a characteristic content of trace elements.

As far as trace elements are concerned, petroleum crudes and bitumens of the USSR can be divided into two large groups:

1. Petroleum crudes and bitumens of the Tertiary era (Baku, Groznyy). In the composition of their ash, silicon and iron predominate, while vanadium, nickel, and copper are either absent or present in negligible quantities.

2. Petroleum crudes and bitumens of the Paleozoic era (Ural-Volga); in the ash of crudes of this group, vanadium, nickel, copper, and iron predominate.

Group 2 is in turn divided into two subgroups according to the V/Ni ratio:

a. Petroleum crudes and bitumens of the Upper Permian, in which V/Ni on the average amounts to 5.

b. Petroleum crudes and bitumens of Lower Permian and Carboniferous origin with an average V/Ni ratio of 2-3.

These relationships apply to normal, liquid petroleum crudes as well as to viscous oils of low mobility and solid bitumens (asphaltites).

The V/Ni ratio enabled Gulyayeva to differentiate between Ufa, coal, and Artinsk petroleums. The data in question can be used for establishing the stratigraphic group to which the caustobilite belongs in cases where the age of the petroleum is not known. In drawing conclusions of this type, one must take into consideration factors affecting trace-element composition as well as the ratio of these elements. These factors include weathering to a great extent, under participation of oxygen and water, as well as adsorption processes taking place while the petroleum moves along a stratum. Furthermore, a considerable amount of rock may be mixed with the bitumen. The rock matter is occasionally difficult to separate from the organic mass (asphaltites). Under the circumstances, its presence may affect the V/Ni ratio, because some rocks contain a considerable amount of these elements.

Geochemical investigation of the crude oils and solid bitumens of Second Baku indicated that only a few steps or phases were involved in their generation. Investigation by the same methods of petroleum crude in the Azerbaydzhan productive thickness established in an incontrovertible manner that this petroleum is of a secondary nature.

In regard to the formation of petroleum occurrences and methods of prospecting for them, the following conclusions can be made.

In view of the fact that not all petroleum occurrences were formed under identical conditions, there can be no single method of prospecting which is applicable throughout the USSR. However, some general relationships may be traced.

There are two types of petroleum deposits in the USSR: tectonic and stratigraphic. The search for anticlinal folds has always been one of the most important tasks of petroleum geologists, and it still remains important at present. However, as early as 1910, since the first investigations carried out by I. M. Gubkin, the existence of stratigraphic deposits also became known.

As far as stratigraphic or zonal petroleum occurrences in the USSR are concerned, three types of them are known:

1. Deposits of the type occurring in the Yasamal'sk Valley and Chakhnaglyar on the Apsheron Peninsula. These deposits are conditioned by the sloping out of stratigraphic units in porous rocks that are contemporary with them.

2. Deposits of the Eastern Kuban' type (i.e., the Maykop deposits) which occur under conditions involving erosion of ancient deposits by ancient water streams and sea water in such a manner that small bays were formed. Subsequently, there was filling in of eroded areas with terrigenous material.

3. Occurrences of the Ishimbayev and Chusovskiye Gorodki type, which are conditioned by the presence of buried reef-forming mountain masses that are stratigraphically sharply delineated.

Solution of problems connected with the type of petroleum occurrences is regarded as one of the most important tasks of petroleum geology. In order that any petroleum field or any petroleum deposit may form, the presence of porous rocks is necessary. Originally, the only method of investigating quantitatively the properties of a rock as a petroleum collector was by determining its porosity. The qualitative aspects of problems connected with petroleum collectors were studied by P. P Avdusin and M. A. Tsvetkova, who developed their own methods of investigating collectors and also devised a new method of classifying them.

We are now faced with problems pertaining to the mapping of facies of collectors in any region where a search for petroleum is conducted. This is the second part of the task which must be carried out in evaluating the chances of finding petroleum.

In order to conclude definitely that petroleum is present at any site, one must actually observe its presence. How can this be done, when any signs of petroleum are absent on the surface? As a rule, geophysical methods alone are, ineffective in that respect. In our opinion, the redox potential method is best suited for that purpose. Gas sampling according to V. A. Sokolov is also definitely applicable, and determination of gas dissolved in water is promising. V. A. Sulin's hydrochemical method has been discussed above.

A knowledge of the type of petroleum deposits, particularly of deposits contemporary with various types of stratigraphic beds [literally "traps"] that hold them, involves a thorough study of paleogeographic problems. V. P. Baturin, who died on 8 November 1945, was a pioneer in this field of petroleum geology.

Only thorough paleogeographic investigations can establish the degree of preservation of petroleum deposits. There is no other way of clarifying the role of the Akchygal'sk transgression in the Tadzhik SSR, the conditions under which the Tournay limestone beds in the region of Second Baku have been washed out, etc. Hydrogeology must be applied on a wider scale in the search for petroleum.

Taking into consideration everything that has been said concerning the special characteristics of petroleum occurrences in the USSR, it must be emphasized that in prospecting for petroleum, we are still in the earliest stage, i.e., we get petroleum from anticline arches or zones in the vicinity of these arches. Methods of searching for stratigraphic deposits have not yet been developed, and the most promising task of petroleum geologists lies in this field.

The multiplicity of ways in which the majority of petroleum occurrences was formed and the fact that any petroleum deposit may be formed by migration indicate that there must be large accumulations of petroleum in zones where the strata sink to a great depth. Stratigraphic deposits will predominate there. The truth of this is confirmed by the experience acquired at Baku. In other words, petroleum must be searched for at great distances from anticline arches, in deep parts of monoclines, etc.

This will constitute the second stage of prospecting for petroleum in the USSR. This second stage will make the USSR the foremost petroleum-producing country in the world.

- E N D -